

LA-UR- 04-0274

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Title: High Pressure Pu EOS Experiment (U)

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Submitted to: AWE Conference  
September 10, 2004  
Aldermaston, United Kingdom



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Form 836 (8/00)

# High pressure Pu EOS experiment

Chris Morris

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## Abstract

A new method for determining material properties at high pressure is presented. High pressures are obtained using an implosion geometry. The resulting densities are inferred from the transmission of an 800 MeV proton beam. Experiments on static objects show that sub 1% measurements are possible.

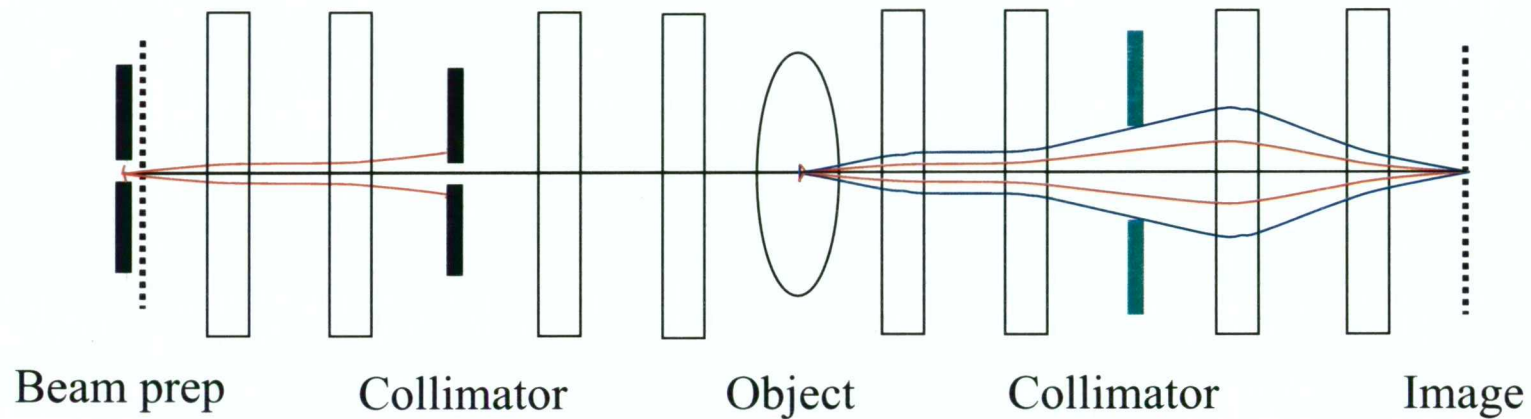
Presented at: AWE 10-September-2004, Aldermaston, UK

# High pressure Pu EOS experiment

- Use well controlled implosion to obtain relevant pressures
- Scale the experiment to remove criticality issues and to simplified security and AB concerns
- Use simplified geometry to reduce containment issues and overburden
- Measure transmission as a function of time with a pencil beam to infer the maximum compression

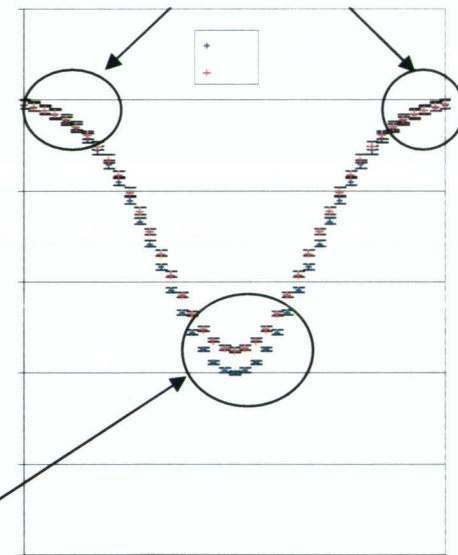
similar to RaLa experiments of the 40's-60's.

# High pressure Pu EOS experiment



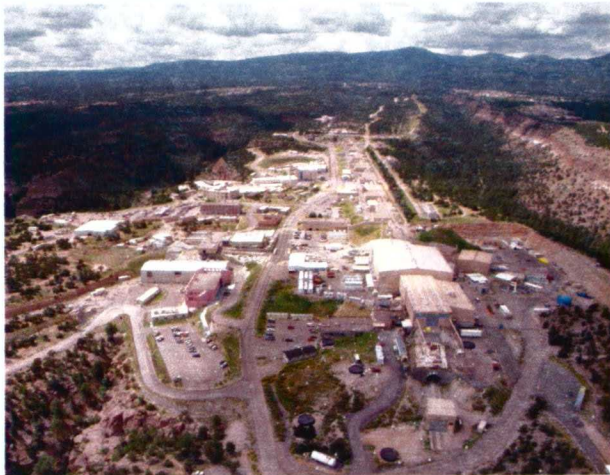
- Input collimator defines beam size and position
- Second collimator trims halo from beam
- Input detector measures incident flux
- Image detector measures transmitted flux.

Early and late time data provide normalization check



Errors due to timing uncertainties are reduced by fitting the curves to find the maximum compression

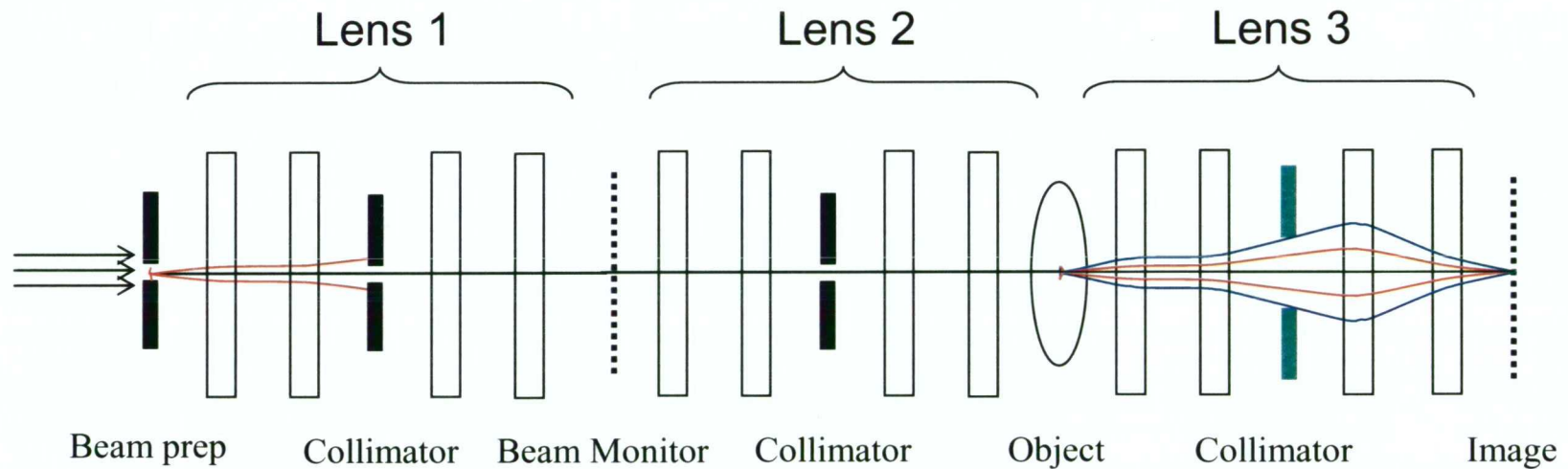
# LANSCCE 800 MeV proton radiography facility



$$t = e^{-\frac{l}{\lambda_2}} \left(1 - e^{-\frac{\theta_c^2}{X}}\right)$$

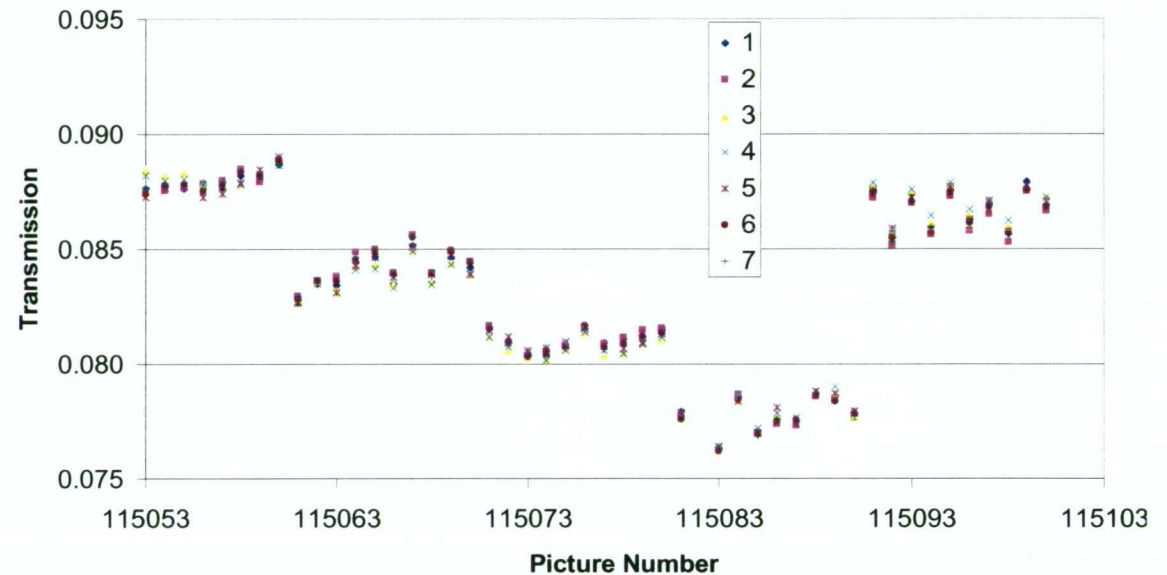
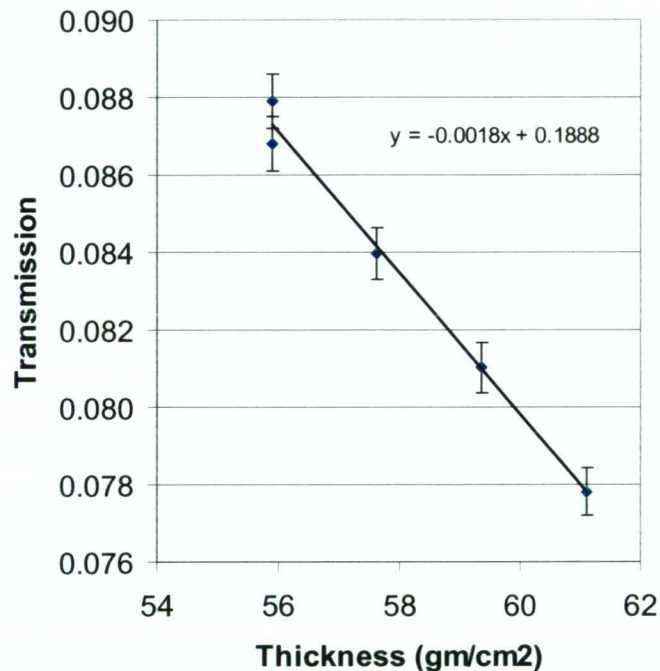


# Merrill Modification



- Lens 1 cleans up the beam transmitted by the collimator
- Lens 2 transports the pencil beam to the object
- Lens 3 images the transmitted beam

# Initial data using diode gated CCD cameras



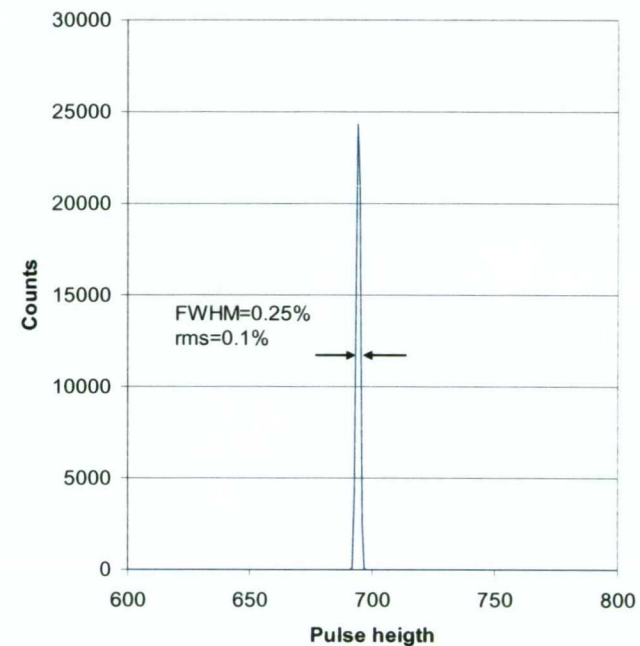
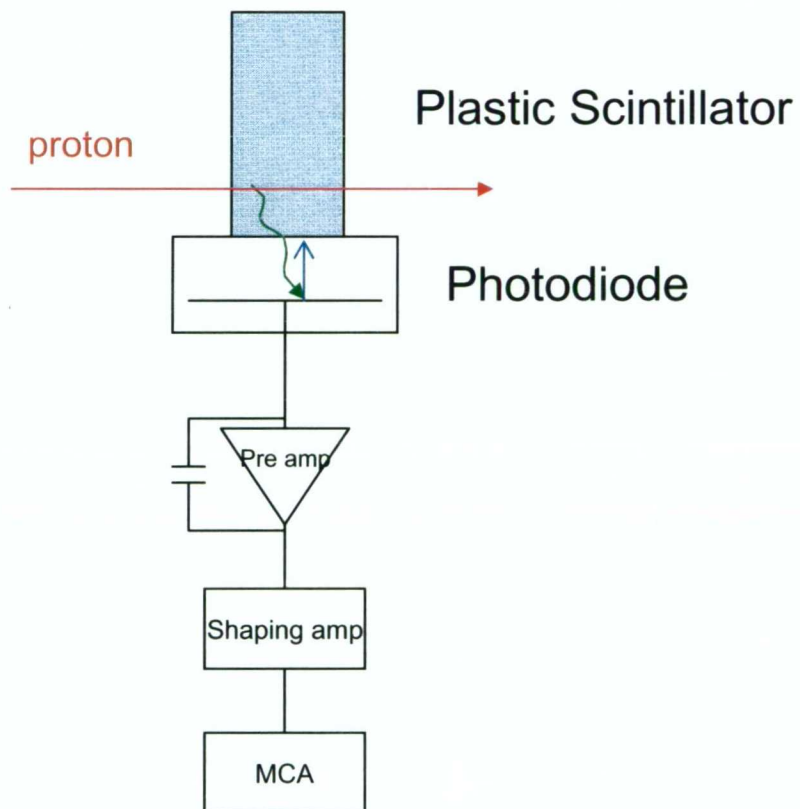
- Normalization Uncertainty: 0.8%
- CCD camera uncertainty: 0.2%

We can do a 0.2% experiment (7 times) by cloning the detector we have.

We can do a 0.2% experiment at 100 times with electronic streak cameras.

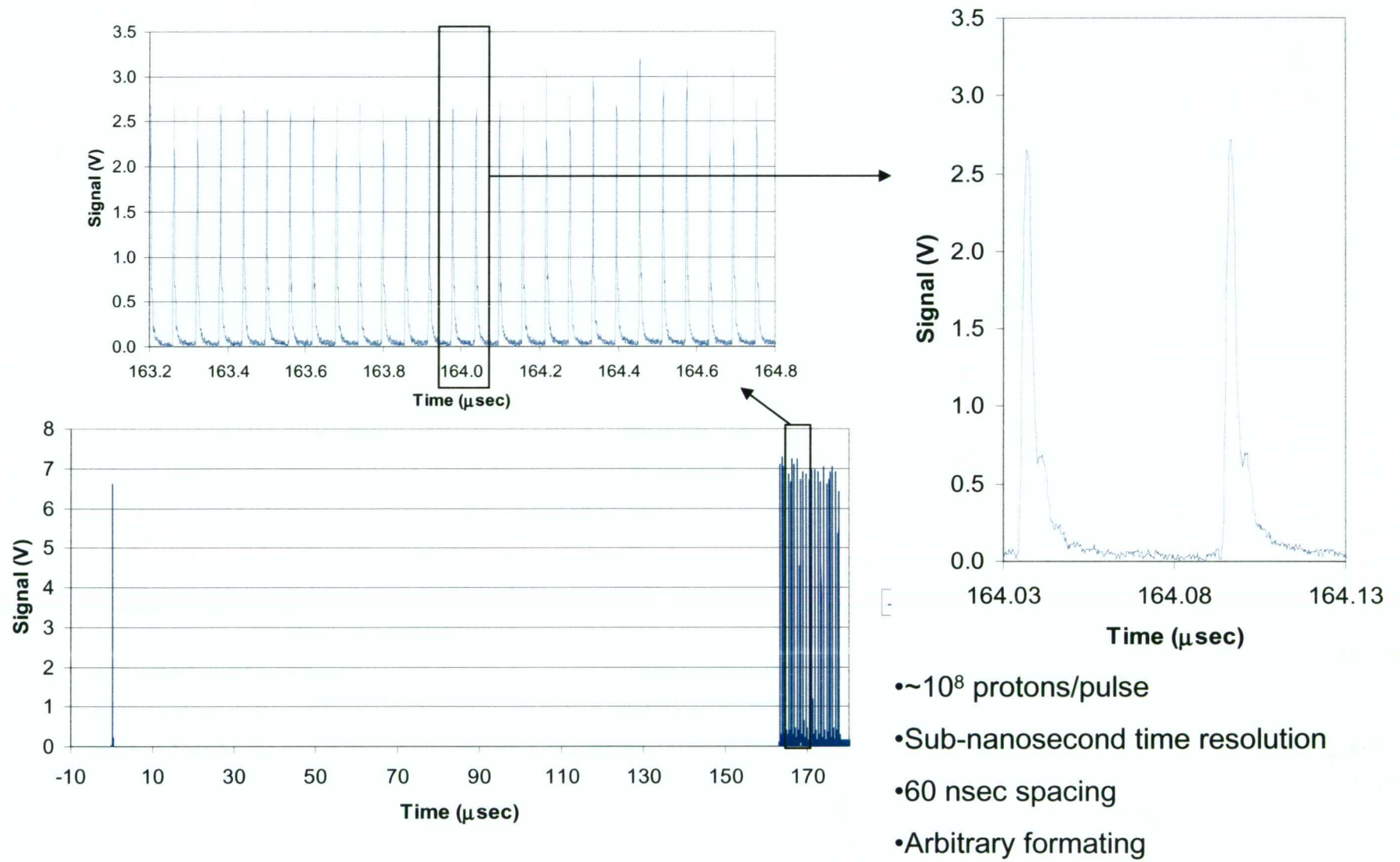
# Detector

Need a detector with 0.1% precision and a dynamic range of 10 with nsec response.

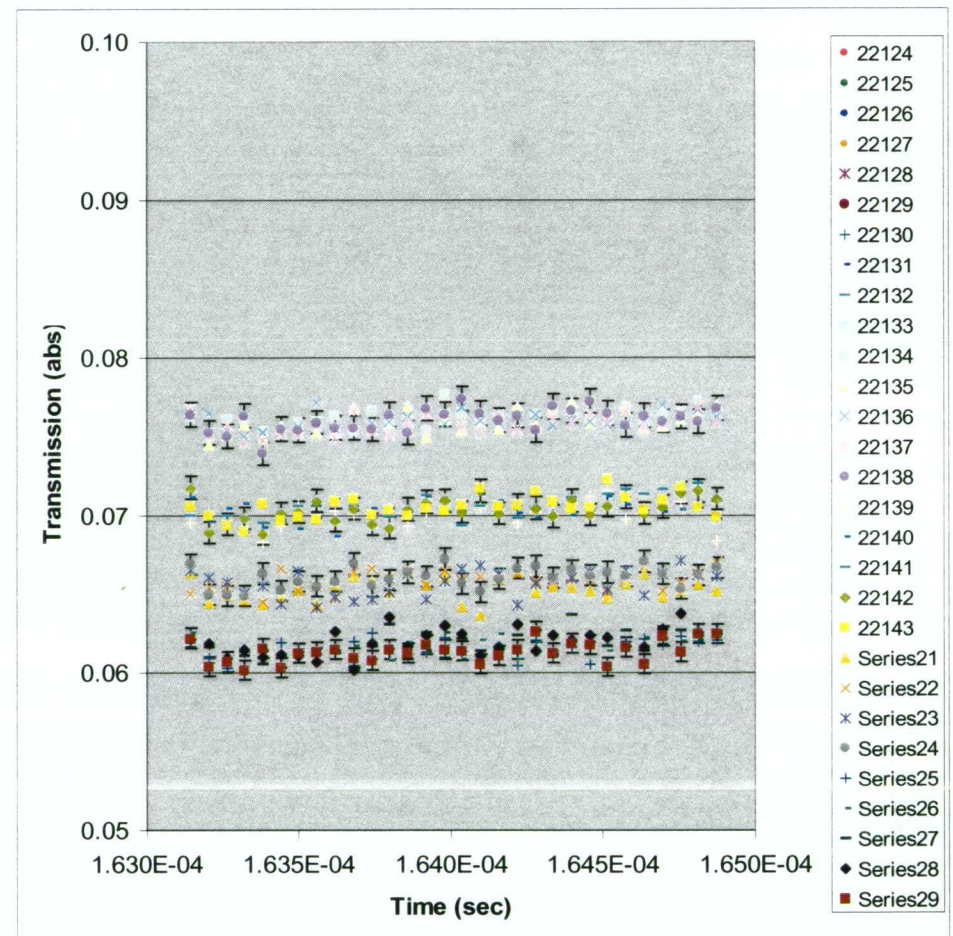
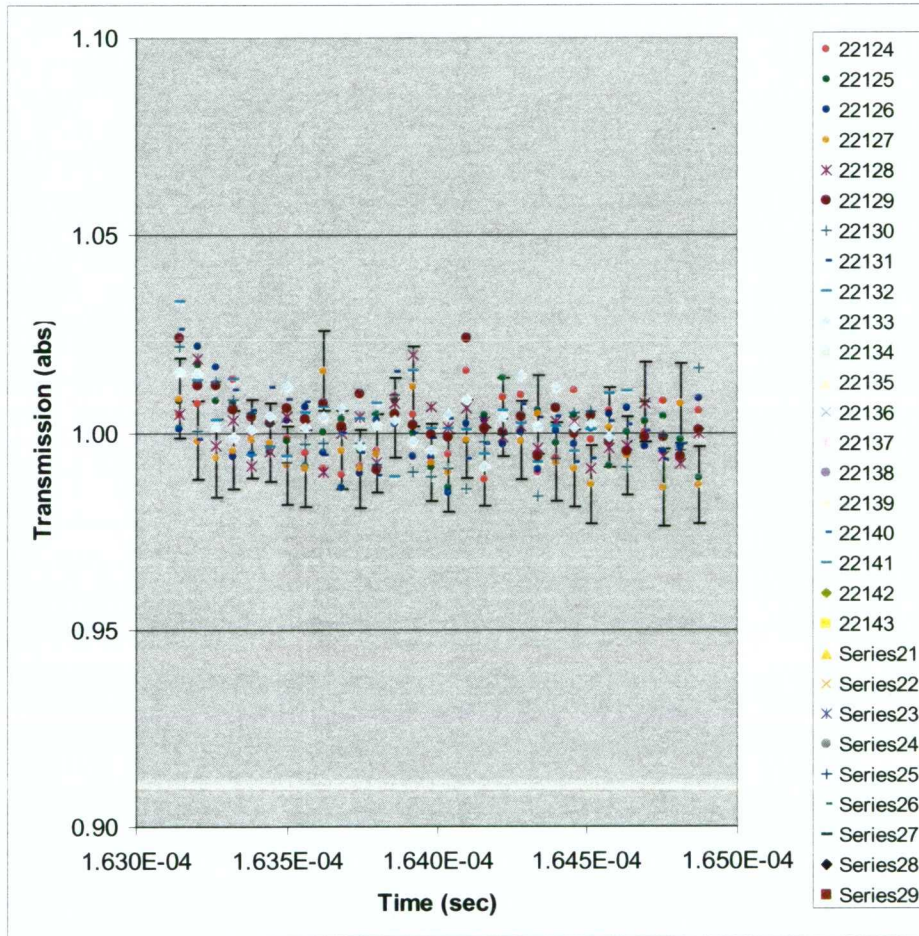




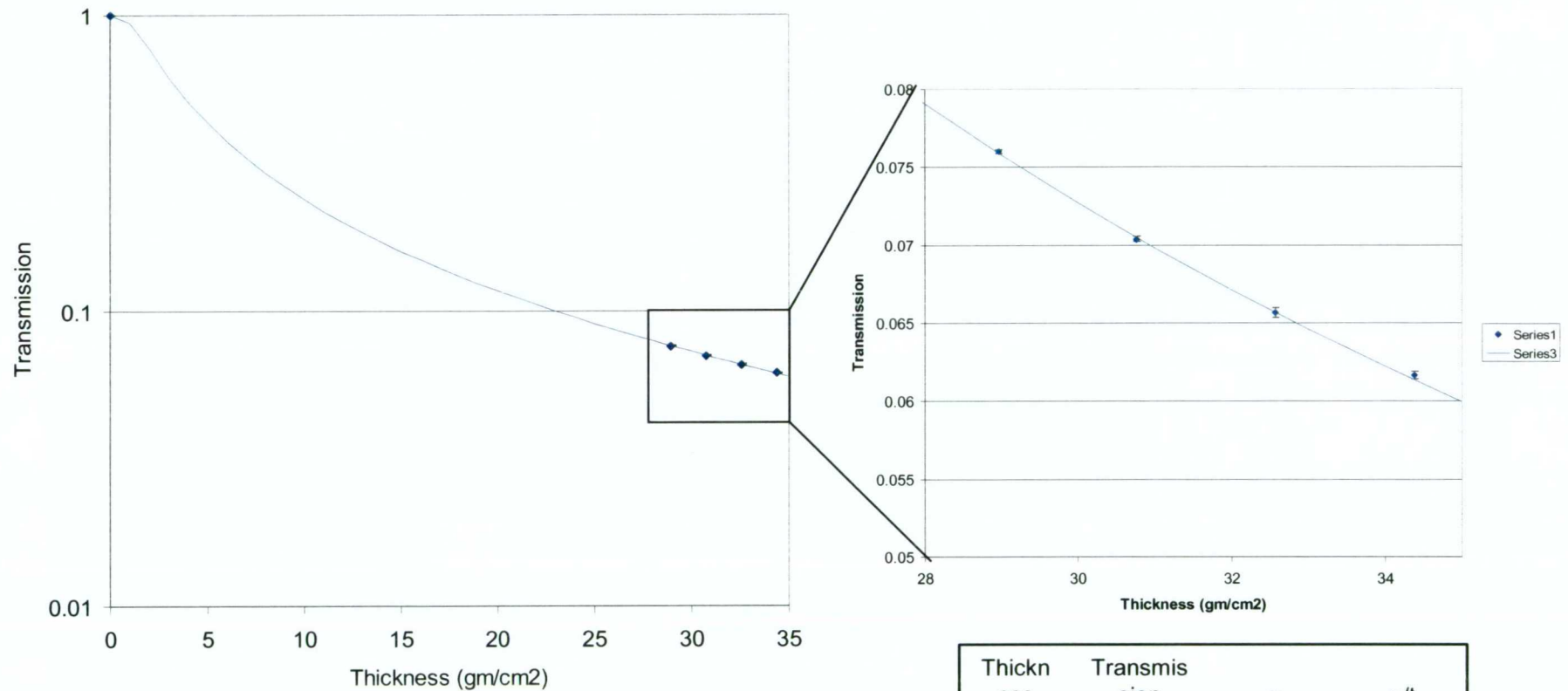
# The LANSCE beam format is flexible



# 60 ns spaced pulse train



# Transmission vs. thickness



Thickn ess	Transmis sion	$\sigma$	$\sigma/t$
0.00	1.00E+00	2.19E-03	2.19E-03
28.96	7.60E-02	1.37E-04	1.80E-03
30.77	7.04E-02	1.74E-04	2.48E-03
32.58	6.57E-02	3.19E-04	4.86E-03
34.39	6.16E-02	2.34E-04	3.80E-03



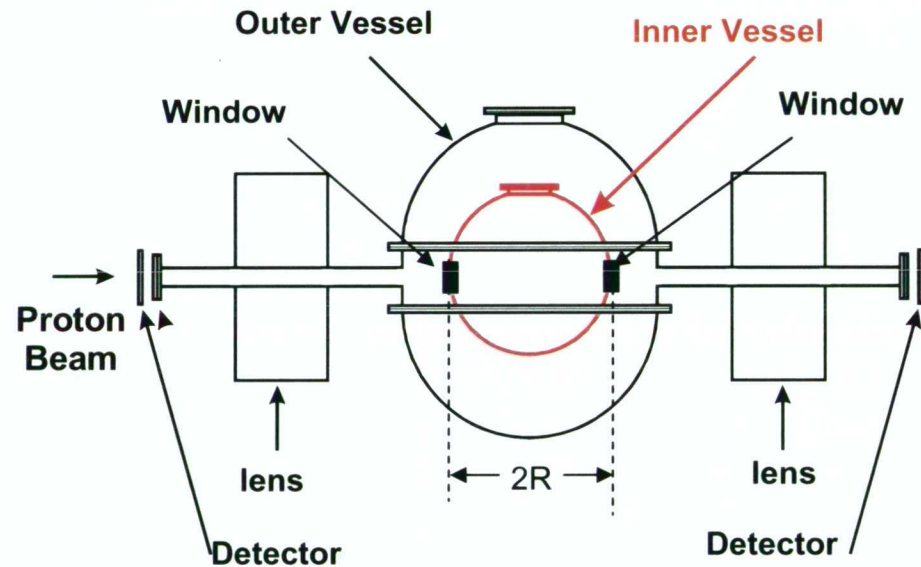
# Position Resolution

- Multiple scattering in the window.

$$\Delta x_{\text{window}} = \theta R$$

where

$$\theta_w \approx \frac{14.1}{\beta p} \sqrt{\frac{L_{\text{window}}}{L_{\text{Rad}}}}$$



Thickness (cm)	Material	$R$ (cm)	$L_{\text{rad}}$ (cm)	$T$ (GeV)	$p$ (GeV/c)	$\theta$ (rad)	$\Delta x$ FWHM cm
1	Al	30	8.9	0.8	1463.147	0.002787	0.196889

# Pedicini aging experiments

Program scope	<b>Safety</b>	
	EIS, 3FTE, 1.5 yrs	3000
	AB, 2-3 safety, 2-3 engineers, 1.5 years	2500
	Waste, 1000/exp x 4	4000
<ul style="list-style-type: none"> <li>•Static tests</li> <li>•2 surrogate experiments</li> <li>•4 Dynamic experiments with Pu</li> </ul>	<b>Beamline Upgrades</b>	
	Detectors	600
	Beam design, test objects, collimators	300
Safety considerations	<b>Security/Storage</b>	
	MBA for storage	150
	Security for < 400g	200
<ul style="list-style-type: none"> <li>•Use DYNEX vessel                             <ul style="list-style-type: none"> <li>•Leverage existing work on Authorization Basis</li> </ul> </li> <li>•Seal Area C                             <ul style="list-style-type: none"> <li>•Triple containment for the experiments</li> <li>•Provides defense in depth</li> <li>•No public exposure</li> </ul> </li> <li>•Locate assembly room in area C                             <ul style="list-style-type: none"> <li>•Provides double containment for all work.</li> </ul> </li> </ul>	<b>Experiments</b>	
	Experiments, surrogate, 500 each x2	1000
	Experiments, hi fi, 1000 each x 4	4000
	<b>Containment System</b>	
	Proof shots, overpressure tests	750
	Vessels, 6' already designed	2500
	Seal dome	600
	Assembly room (ESA), fixture, crane, calculations	6000
	Chamber 8 type vessel	3500
	Installation of above vessel, new crane	1250
	<b>TOTAL</b>	<b>30350</b>
	Contingency, 30%	39455



# Thresholds

## Release\*

- 8.4 gm
- 900

## Criticality

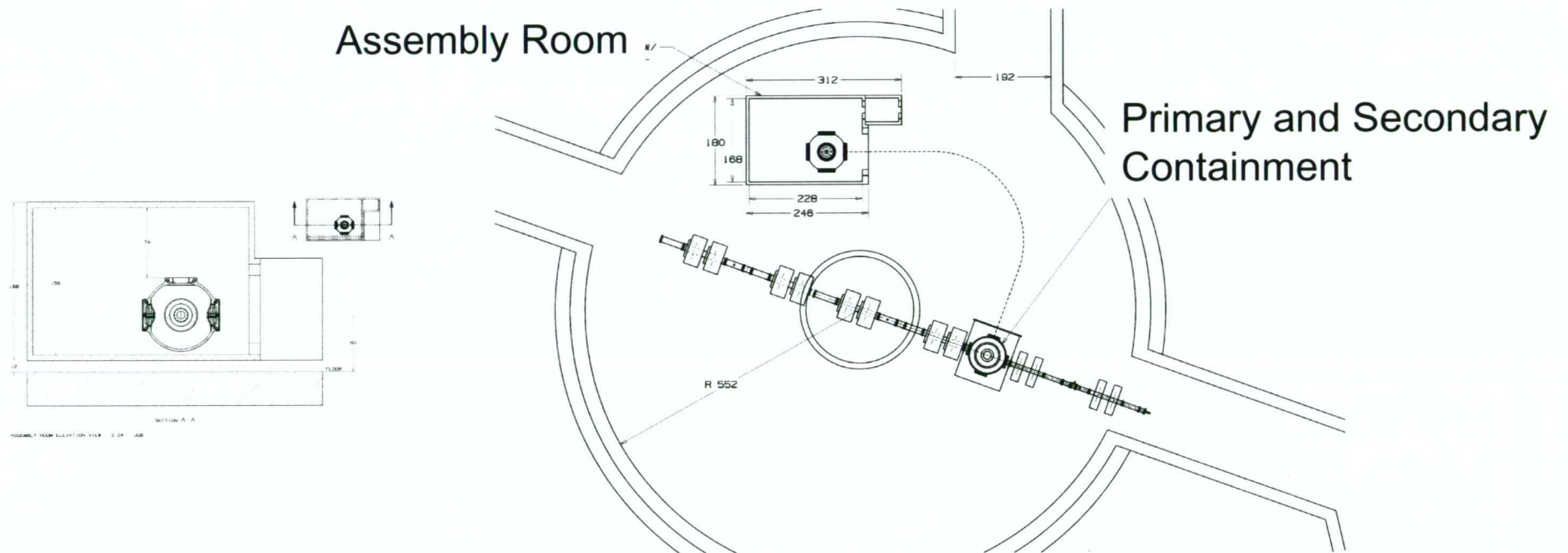
- 450

## Security

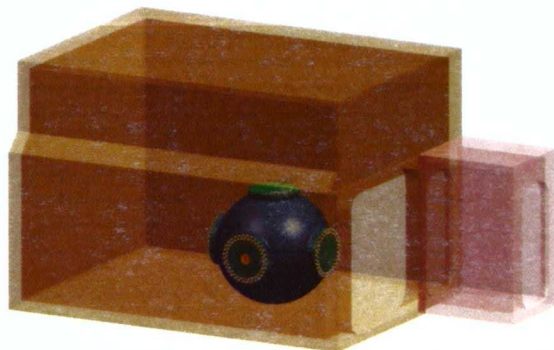
- 400
- 2000

\* 1.e-3 assumed release  
fraction

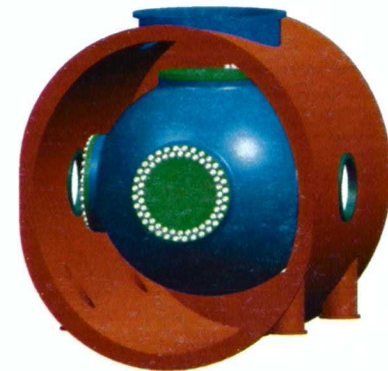
# Layout of line C facilities

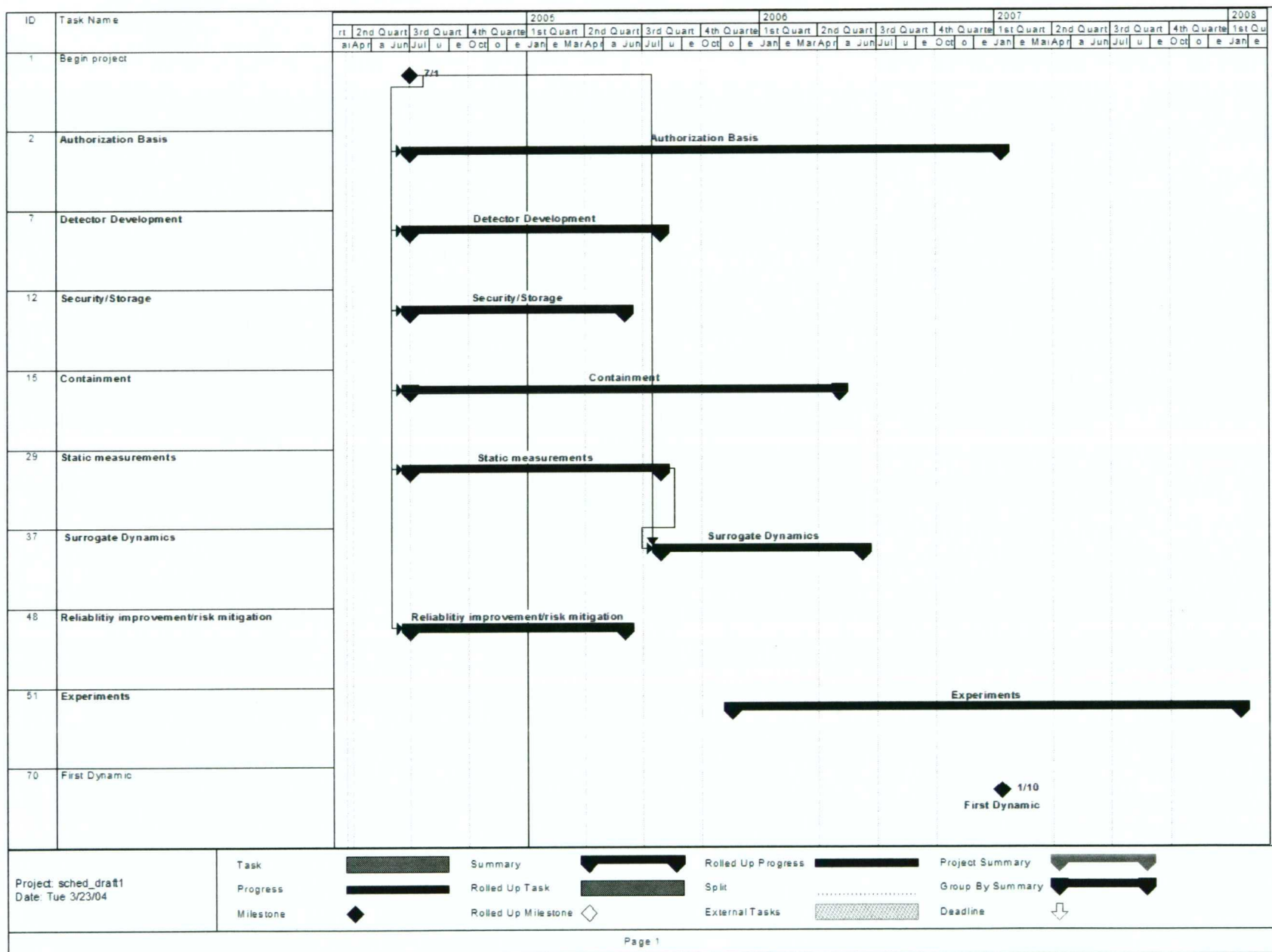


Primary Vessel in Assembly Room



Primary Vessel in Secondary Container





# pRad aging experiment

- Have reached a precision of  $\sim\pm 0.3\%$  in  $\Delta\rho_A/\rho_A$ 
  - This takes credit for averaging
- Need better recording
  - Electronic streak camera
  - Hope to achieve  $<0.25\%$ /point
- Technique is robust
  - Timing established by measuring minimum
  - Early and late time measurements provide normalization check
  - Alignment and stability are ensured by experimental setup